Bringing students into research by hacking global health

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Abstract
This essay is an evaluative case study reporting on the preparation, execution, and evaluation of a Global Health Hackathon as a teaching method piloted as part of the 'Introduction to Global Health' undergraduate module in the Department of Social Science, Health & Medicine at King's College London. I provide a critical evaluation of my practice by drawing on relevant academic literature concerned with the research-teaching nexus and inquiry-based learning, course material to describe the hackathon and its related components, and student evaluations to reflect on the overall module experience. I conclude with some final reflections and thoughts of what it would take to institutionalize research-based teaching and learning in our department in a more sustainable manner.

Keywords: Inquiry-based learning, research-teaching nexus, hackathon, global health, undergraduate

Introduction

Intrigued by the scholarly work concerned with 'linking research, practice and teaching' to enhance students' learning, I decided to make research a central component of the 'Introduction to Global Health II' undergraduate module offered by the Department of Social Science, Health & Medicine at King's College London in Spring 2014. Together with my students, I organized our first Global Health Hackathon with funding from the College Teaching Fund (CTF). Our hackathon focused on finding simple technological solutions to common global health problems. The goal was to assist in closing the 'know-do' gap in global health through innovative Knowledge Translation and Exchange (KTE) methods.

Hackathons originally started in the IT community as computing marathons where programmers, project managers, and graphic and interface designers collaborated intensively on software projects to design the next 'killer app' within thirty food-fuelled hours (Leckart, 2012). They are now beginning to be employed widely in educational (LSE, NYU, MIT), creative (BBC News Hack, Music Hack Day), corporate (Facebook), and government (National Hack the Government Day) sectors. I set out to pilot this novel methodology in our 'Introduction to Global Health II' module in order to foster a participatory approach to learning and allow students to collaborate in interdisciplinary teams to invent or redesign tangible outputs. Our overall aim was to support students in their continuing professional development and provide them with research and technological experience, while also expanding their knowledge in global health more effectively.

This essay offers a description of and reflection on the hackathon as a method for teaching. I first provide an overview of the literature concerned with the 'research-teaching nexus' and 'inquiry-based learning.' Subsequently I outline the module briefly and then describe the hackathon itself. I will conclude with some reflections and thoughts of what it would take to institutionalize research-based teaching and learning in a more sustainable manner.

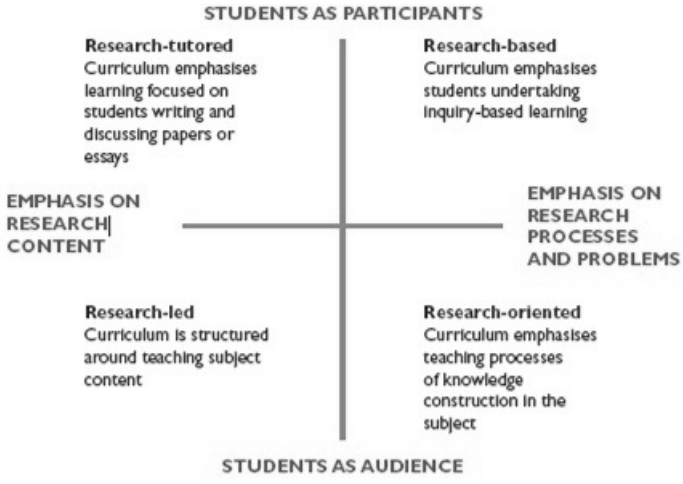
Linking research with teaching to achieve better learning outcomes

The research-teaching nexus

While previously research and teaching were perceived as discrete activities (Brew, 2003), current pedagogical approaches emphasize that the two domains can enhance each other if properly intertwined (Marsh and Hattie, 2002). Research is believed to enrich teaching, especially when teachers transmit their own research outcomes to the students and thereby influence the students' attitudes toward knowledge (Visser-Wijnveen, 2010; UKPSF, 2012). Teaching, on the other hand, is considered to be a practice that can effectively influence research through the creation of spaces that foster critical thinking and discussions about research and related strategies (Sproken-Smith and Walker, 2010). Here a form of pedagogy is emphasized that 'functions to integrate research and teaching by reconceptualizing students and instructors as compatriots in the search for knowledge' (Justice *et al.*, 2007).

Different conceptual frameworks have been created to illustrate the research-teaching nexus. For instance, Griffiths (2004) distinguishes between four forms of teaching that increasingly lead students toward participating in research: *Research-led teaching* allows teachers to build the content of the curriculum on their specialist research interests; *research-oriented teaching* highlights how knowledge is generated in the field and provides students with the opportunity to learn about their teachers' current research projects; *research-based teaching* provides the opportunity to design curricula around inquiry-based activities; and *research informed* teaching permits students to learn the course content through actively participating in research projects. Healey (2005) further developed this framework by merging the different teaching forms into a model that connects curriculum design with the research-teaching nexus on two axes (Fig. 1). One axis organizes approaches to linking teaching and research depending on the degree to which students are treated as active participants or as audience. The second axis organizes the approach as emphasizing research content or research process and problems.

Figure 1: 'Curriculum design and the research-teaching nexus' (Jenkins *et al*., 2007 based on Healey, 2005)



Several scholars argue that learning is most effective when students are engaged in research as active and reflective participants, while others point out that evidence is lacking with regards to the success of the linkage. Marsh and Hattie (2002) refer to a meta-analysis investigating the connection between teaching and research among university academics and conclude that '[t]he common belief that research and teaching are inextricably entwined is an enduring myth. At best, research and teaching are very loosely coupled'. They discuss an important rift between theory and practice, and call for further systematic investigation.

The promotion of inquiry-based learning

Building on the insights gained from research about the benefits and obstacles of the research-teaching nexus, scholars, academic administrators, and institutions increasingly promote 'inquiry-based learning' (IBL) in higher education. IBL is an umbrella term spanning various pedagogical approaches emphasizing the importance of students' investigative work through learning that involve question-driven rather than topic-driven activities (Aditomo *et al*., 2011). The concept is defined in various ways; Spronken-Smith *et al* (2011) define IBL as teaching approaches 'in which learning is stimulated by a question or issue, learning is based on constructing new knowledge and understanding, the teacher's role is one of a facilitator, and there is a move toward self-directed learning'. Similarly, Oliver (2008) proposes that IBL refers to approaches in which 'some form of problem or task serves as catalyst for student engagement and participation (...), learning comes as a consequence of the information processing that occurs as students work to explore the problem setting and to seek a solution'.

IBL is based on constructivist educational theory that encapsulates the notion that 'what the

learner has to do is to create knowledge' (Biggs, 2003; Levy and Petruli, 2012). Learning how to create knowledge follows a process of 'scaffolding' during which the initial support provided by the teacher tapers off over time while profound and independent learning increases simultaneously (Spronken-Smith and Walker, 2010). Students who adopt a deep approach to learning hone their skills to understand and interpret the underlying meaning of phenomena by working conceptually bringing main ideas, themes, and principles into a conversation with each other. Surface learners, on the other hand, tend to focus on getting a particular task done with the aim of meeting the course requirements with minimal engagement with the material (Marton and Saljo, 1976; Golding, 2011).

The report of the Boyer Commission (1998) was among the first to forcefully advocate for achieving deep learning by tasking undergraduate students in the US to create knowledge, rather than to simply listen to lectures. The report recommends making research-based learning the standard; constructing an inquiry-based freshman year; building on freshman foundation; removing barriers to interdisciplinary education; linking communication skills and course work; using information technology creatively; culminating with a capstone experience; educating graduate students as apprentice teachers; changing faculty reward systems; and cultivating a sense of community. A decade later, the Higher Education Academy in the UK similarly called for new forms of research-based learning and teaching for undergraduate students so as 'to cultivate awareness of research careers, to train students in research skills for employment, and to sustain the advantages of a research-teaching connection in a mass or universal system' (Ramsden, 2008).

Reviews of ongoing IBL approaches in higher education have identified a number of techniques. Aditomo *et al.* (2011) distinguish between eight forms of IBL tasks including scholarly research, simplified research, literature-based inquiry, discussion-based inquiry, applied research, simulated applied research, enactment of practice, and role playing. Studies investigating students' perceptions of and attitudes toward moving from a 'learning paradigm' to a 'discovery paradigm' (Hodge *et al.*, 2008) have largely established that learners acquire knowledge most effectively when engaged in their own research projects. Regularly highlighted benefits include increased confidence, intellectual advancement in operating like a researcher, development of critical thinking and problem-solving skills, and understanding scientific mechanisms and underpinnings, both conceptually and in practice (Brew and Jewell, 2011; Healey *et al.*, 2010; Justice *et al.*, 2007; Spronken-Smith and Walker, 2010; Visser-Winjveen, 2010). However, reviews also show that in many cases students are not actually aware of their teachers' research, experience the workload as too high, are confused by varied assessment products, and do not perceive their investigations as authentic research, but rather as an imitation thereof (Levy and Petruli, 2012; Healy *et al.*, 2010; Spronken-Smith *et al.*, 2011).

Notwithstanding these challenges, scholars largely agree that IBL is a promising approach forward in allowing students to develop skills in self-reflection, critical thinking, the capability to engage in independent inquiry, responsibility for their own learning and intellectual growth and maturity (Spronken-Smith and Walker, 2010).

Involving undergraduate students in research: A Global Health Hackathon

Our introductory module in global health introduces undergraduate students to the key concepts and debates in global health, investigates the knowledge-to-action gap, and uses case studies to illuminate health inequalities and the political, economic, social, and structural forces that perpetuate these disparities. The key educational aims are to introduce students to major concepts and deliberations regarding how to define global health and how it might be secured; introduce them to the knowledge-to-action gap in different fields in global health and strategies that aim to close it; provide students with the skills to critically evaluate such initiatives and to identify the role of key stakeholders in shaping them; demonstrate the value of interdisciplinary approaches to global health; and, last but not least, provide insights into the use of particular methodological and epistemological tools in the production of global health research. To achieve these learning outcomes, students are required to attend lectures and seminars, study assigned readings at home, and submit research papers.

While this format lends itself well to more traditional teacher-centered approaches with a focus on knowledge transmission, I found that it left little room for students to independently construct knowledge and derive at new insights in the field of global health. In order to develop a more dynamic approach to teaching and learning and, thereby, bring students into the world of research, I collaborated with them to carry out the Global Health Hackathon (14 February 2014). Following this event, I asked students to critically engage with their research outputs. For their mid-term examination (24 February 2014), they each created infographics to display their innovative solutions with the help of new software. The infographics were later printed and displayed to the Department and College as part of the SSHM Seminar Series. Finally, each student had to submit a graded essay (24 March 2014) describing, analyzing, and critically reflecting on their research outputs by embedding them into wider global health discourses, employing the concepts that were presented throughout the term.

Twenty-two third-year Study Abroad students (18 female; 4 male) from the US attended the module[1] . Most of them (11) were enrolled in science-related disciplines while only four were enrolled in the social sciences and humanities at their home universities [2]. Curious to learn about their motivations for taking our global health module, I asked them at the beginning of the first session to write a short note outlining their motivations and what they hoped to learn about global health. Their motivations for taking the module were diverse but included some common features such as learning more about how globalization is connected to health inequities, gaining a better understanding of how social and political determinants affect health, striving to become better informed clinicians in the future, and learning about health systems. Their learning goals encompassed learning about large global health issues, what can be done to solve global health problems, how one can get engaged as a professional, how

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1 The module was only open to Study Abroad students as our BSc in Global Health and Social Medicine had not yet been officially launched.
2 Science disciplines included biology, neuroscience, mathematics, biomedical science, psychology, and biochemistry; Social science and humanities disciplines included English, American studies, and political science.

global health is connected to other aspects of life, and the health gaps between countries.

As none of the students had prior knowledge about global health, I designed and planned learning activities that were more transmission-based at the beginning of the term to provide a solid overview of the field. Based on this, we gradually moved toward independent learning through inquiry and research. In order to monitor teaching and learning effectiveness, I incorporated a number of evaluation methods throughout the term. In the following section, I will describe the different elements and their alignment by focusing on our hackathon.

Preparations for the Global Health Hackathon

Preparing students for the Global Health Hackathon required a participatory action approach. I involved students in the project from the very beginning, not just as participants but also as leaders and decision makers. Through such an active approach to learning I hoped that they would become more proficient with the use of technology, engaging in interdisciplinary collaboration, and being innovative and output oriented. I also included one of our MSc student as co-applicant on the CTF grant and, later, as teaching assistant to help with the conceptualization and realization of the hackathon. She was responsible for working with an undergraduate teaching assistant to help with the organization of the event by recruiting postgraduate students from other departments as volunteers, developing training materials, creating a blog featuring the hackathon and its results, and organizing an infographics exhibition. My rationale was to provide postgraduate students and teaching assistants with the opportunity to translate their theoretical knowledge into practice by working in collaboration with undergraduate students and within a limited time frame. Additionally, I wanted them to gain tutoring and organizational skills while learning how to merge academic knowledge with business experience.

Four weeks before the hackathon took place, the undergraduate students had to form working groups of five to six members. Their first task was to formulate a well-structured 'hackathon challenge' that they would like to tackle during the event. This turned out to be more difficult than I anticipated as the students' first challenge-formulations produced extremely broad and rather unmanageable research problems. However, instead of simply taking the reins into my own hands, I quickly developed a three-stepped approach.

First, each student was asked to formulate a well-structured challenge related to a concrete context and email it to me for feedback prior to the next session. Specifically, they had to identify a particular field in which knowledge is translated and exchanged, locate 'blockages' that hamper important health related knowledge to be properly exchanged and translated into practice, and highlight elements of this problem and the ways they are related to other structural issues in the identified field. Second, during the following session, students had to present their challenges to their working groups in order to discuss them critically. Based on their discussion, they had to pick the two best challenges for further investigation throughout the rest of the week. Third, the session before the hackathon was conceptualized as a two-hour workshop during which each group discussed their two selected challenges by focusing on the following five questions: *Who* is your target population? *What* is the KTE related challenge and its components? *Where* does the target population interact with the problem?

When does the problem occur and why? *How* does the problem unfold and how does it affect the target population? Once they had a good understanding of the challenges, each group had to select one of them for the hackathon.

The developed 'hackathon challenges' included: (1) Resource allocation problems in the medical field that hamper the effective sharing of medical supplies between hospitals and clinics in South Africa; (2) the neglect of HPV vaccination in resource-poor settings like Uganda; (3) the lack of locally relevant evidence on autism and its treatment; and (4) sexual education in the US that bridges the gap between authoritarian and peer-to-peer approaches to sexual education. Following the workshop, students had to read up on their selected problems by engaging with the academic literature, reports, and relevant websites. In the meantime, I distributed the selected challenges to the postgraduate volunteers and two professional digital designers. I expected them to reflect on the challenges and recommend tools and software to the students for the day of the hackathon.

Hacking global health

The hackathon turned out to be an exciting and inspiring full-day event. After the workstations were set up and the agenda of the day introduced, the hackathon started at nine o'clock. Throughout the morning and early afternoon students gathered in their work groups where they were joined by one or more volunteers to further refine their challenge and its components and to discuss ways in which the respective problem could be improved. They began to formulate possible recommendations that could be made to solve or improve the situation, to outline the pathways that would need to be created in order to allow the possible solution to actually change the problem; and to think about whether or not the recommendations would actually have the capacity to change the flow of knowledge. There was an immense buzz in the room as students and volunteers discussed and refined their challenges and began to think about possible solutions.

While lunch was provided, no official break was scheduled in order not to lose the momentum of the heightened adrenalin and attention. Over the course of the afternoon, the teams agreed on a possible solution for their challenge and set out to refine its components and to gain a better understanding about how each component would add to solving the problem. Moreover, they started with building prototypes or actually functioning technical solutions with the help of the volunteers. The goal was not to have a fully functioning tool but a solid outline that would not require much more tweaking before becoming 'reality'. At five o'clock in the afternoon, each group had to present their challenge and respective solution formally.

The outcomes were impressive and included: (1) A platform that would enable hospitals and clinics in South Africa to record their inventory and prioritize specific local needs to facilitate exchange, while at the same time giving the Ministry of Health and private donors access to this information to circumvent resource waste in some sectors and inadequate supplies in others. (2) A new HPV vaccination program that would reach girls in schools as well as girls who dropped out early through free texting services, a buddy program, and an interactive website that includes vital educational material, a registration and location platform, and a tool for appointment reminders. (3) A web-based platform that offers global information

about autism and a questionnaire that would allow community health workers rather than researchers or clinicians to gather locally relevant data on autism to expand the evidence base through surveys and testimonies. (4) A sexual education website that bridges peer-to-peer and more authoritarian approaches currently employed in the US through a needs assessment and research component, safe and anonymous spaces for information gathering and sharing, and interactive components between users of the platform through 'show' and 'tell' components as well as content trending.

I was amazed by how much the students learned over a very short period of time about particular diseases, challenges related to providing adequate healthcare in particular settings, benefits and limits of current knowledge exchange strategies employed by global health interventionists, and the targeted use of new and interactive technologies and communication methods that could enhance information flow and thereby improve clinical practice. While able to provide insight into key concepts, debates, and problems in global health through lectures and readings, I could have never transmitted such in-depth and complex knowledge through a traditional lecture-based approach alone.

Evaluation of the module

To evaluate the hackathon and overall module experience I employed a number of strategies. (1) On KEATS, the King's College London online educational portal, a message board for discussion was created that allowed students to exchange ideas and opinions with other participants. (2) An anonymous mid-term in-class feedback form was distributed to gain insight into student satisfaction and learning, and to modify teaching practices if necessary. The form included a mix of free-response and quantitative questions. (3) A similar anonymous in-class feedback form was handed out at the end of the semester to allow students to provide feedback on the module as a whole. (4) Students were encouraged to meet with me during office hours to discuss the course, share ideas for the assignments, and talk about any difficulties that were affecting their work. Here, I will only report the results of the final module evaluation due to the limited space.

In total fifteen students filled out the questionnaire. The following table shows student ratings regarding enjoyment, learning, and reading material, rating their answers on a scale of 1 to 10 where 1 equals 'not a lot' and ten equals 'a great deal.' The results indicate that students had an overall positive experience and that there exists an almost ideal alignment between enjoyment of the module and learning with how difficult the readings were perceived.

Table 1: Enjoyment, learning, reading materials

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
How much did you enjoy the module?						1	2	5	4	3
How much did you learn from this module?						2	4	3	1	5
How difficult did you find the reading material?		1	1	1	6	3	2			1

In order to evaluate the preparation for assignments and fulfilment of the module aims/objectives, students rated their answers on a scale from very well (1), quite well (2), not very well (3), and not at all (4). Moreover, they had the possibility to provide written feedback for each of the categories.

Table 2: Preparation and aims/objectives

	1	2	3	4
How well did the module prepare you for the assignment?	5	9	1	
How well did the module fulfill the following: To introduce students to key concepts and debates regarding what global health is and how it might be secured	11	4		
How well did the module fulfill the following: To introduce students to the knowledge to action gap in different fields in global health and strategies that aim to close it?	9	5	1	
How well did the module fulfill the following: To provide students with the skills to critically evaluate such initiatives (strategies to close the know-do-gap) and to identify the role of key stakeholders in shaping them	9	5	1	
How well did the module fulfill the following: To demonstrate the value of interdisciplinary approaches to global health.	9	6		

The overwhelmingly positive reaction to the delivery of content was also reflected in the written feedback, which included two additional categories: 'Three good things about this module were…' and 'Three things about the module which could be improved were…' In the following, I will present the written feedback based on thematic analysis and by focusing on the topics that received most attention by the students.[3]

The 'content and content delivery' of the module received most attention and resulted in exclusively positive feedback. A student wrote for instance, 'good background given on global health and enjoyed the close look at certain diseases' while others highlighted the 'current research base' of the lectures and the interesting material and wide range of topics covered. Another topic that received almost as much feedback was 'preparation for assignments.' Many students indicated that they enjoyed the assignments, praising them for being creative and different from what they were used to, allowing them to think about global health in a vast variety of ways, and giving them the opportunity to employ new skills. A typical response was, 'The assignments were very well explained and a good measure of our course'. However, almost as many comments were provided with regards to the wish for more preparation and guidance, and to explore a greater diversity of topics rather than focusing only on the hackathon challenge. One student recommended, 'More strict guidelines for the hackathon and more software teaching for infographics' and someone else noted, 'I enjoyed the hackathon and the group work with it. I also enjoyed the infographic assignment.

I would have liked a bit more preparation and guidance to aid in the experience.' I probably overestimated the technological savvy of some of the students, assuming that they would be able to familiarize themselves with the software faster and more independently. Consequently, I consider the feedback as extremely valuable and will make sure to set more time aside to provide students with additional training and, thereby, allow independent learning to happen at a slower pace.

Other topics that generated a great number of responses included my 'teaching style', which was described positively highlighting that I presented the material in an organized, interesting, and interactive way, that I took enough time to meet with students individually, that I answered questions thoroughly inside and outside the classroom, and that I showed great patience. One student expressed for instance, 'you were a great teacher and taught at a level which everyone could learn and relate to.' The course readings sparked more diverse comments. It was positively noted that they were enjoyable and pertinent. One student remarked, 'I really enjoyed the readings and thought they were quite accessible and interesting'. More critical reflections indicated that the readings could have been more approachable and were 'sometimes dull' not always relating to the class discussion and 'sometimes didn't feel applicable to the final paper'.

The topics 'hackathon' and 'group work' with peers and the volunteers were also widely commented on indicating that the gradual development of a community of learners was indeed valued and considered important. Typical comments were: 'the idea of a hackathon was novel and a creative way to learn'; 'I enjoyed the hackathon and infographics – they were different from the typical papers and exams and allowed for a lot of creativity'; and 'hackathon and infographic gave opportunities to use new skills and work with others'. One student suggested involving the volunteers not only during the hackathon but also in some of the seminar sessions throughout the course. This is an interesting suggestion as it would allow for the community of learners to become more consolidated and reach beyond the classroom.

Less frequent comments referred to the 'lectures' and 'learning'. Several students reflected that they learned a lot from the lectures and that the guest lecturers were well chosen and their presentations very interesting and informative. A student wrote, 'everything was new to me and I was enthralled the whole time!' while another one wrote, 'I am not a 'science person' but I felt comfortable in this class because it approached global health from so many disciplines'. One person would have preferred more lectures while someone else suggested including additional guest lectures to be exposed to a wider range of teaching styles. The comments made apparent that lectures continue to play an important role in students' learning and that they can be enjoyable and stimulating. Thus, a move toward 'discovery-based learning' should not deprive students from lectures, but rather offer a balanced mix between lectures, seminars, and more independent research-based learning.

The analysis of the comments shows that more 'traditional' aspects of learning and teaching were highlighted by the students while crucial IBL concepts like 'new forms of assessment', 'creativity', 'interdisciplinarity', 'skills', etc. received a lot less commentary. Yet, despite the shortage of comments with regards to these newer teaching and learning techniques, this

does not mean that they did not play an important role in the students' learning. It would be interesting to further investigate how such newer techniques interact with more traditional ones and, in combination, enhance students' learning in the long-term.

Reflections and outlook

My aim of piloting the Global Health Hackathon was to cultivate an interactive, research rich environment in which students could engage with the lecture material and new technologies in practical ways. Through a participatory action approach it was possible for both undergraduate and graduate students to become proficient in critical thinking as well as in '21st-century skills' including on-the-spot thinking, presentation skills, working with different software, creating prototypes for websites and apps, and distributing their work. I consider these not only to be important academic skills but also resume and career building experiences.

Such a research-based approach required me to consider teaching and learning together with assessment strategies to ensure the suitable alignment of learning outcomes, teaching and learning activities (Biggs, 2003; UKPSF, 2012). While I put a lot of thought into sequencing the various elements to ensure an appropriate alignment with the learning outcomes, students made important recommendations for future improvements. Firstly, approaches that use communication skills, information technology, and software creatively need to have a solid training component inbuilt. Such training would allow students to become more confident in the use of technology and, thereby, focus more on content and tangible outcomes. Secondly, in order to consolidate the bonding experience between students and volunteers, working groups could remain active throughout the semester to further develop newly acquired skills. This would expose undergraduate students to more interdisciplinary learning while graduate students could gain additional experience as apprentice teachers. Thirdly, it is important to choose course readings and other information materials not only with a focus on whether they are up-to-date and aligned with a particular session, but also by connecting them with the assignments more effectively.

Besides aiming to improve my own teaching along the lines mentioned above, it is important to contemplate how to make research-based approaches to teaching part of my department's education strategy. First of all, it would be vital that we begin to perceive undergraduate students as co-developers of our teaching and research, and engage them in our line of work beyond the classroom. This, in turn, would require that colleagues within the department and across the college promote a culture allowing for inquiry-based and interdisciplinary teaching and learning. At the same time, it would be necessary to take existing structural barriers into account such as the lack of funding for teaching related activities provided by the college and other academic funding bodies or the emphasis on research and publications dictated by the Research Excellence Framework. 'Constructive alignment' has to happen inside the classroom as well as at college and even national levels if inquiry-based learning is to be instituted in a sustainable manner in UK higher education.

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